HEAT PUMP OPPORTUNITIES FOR MAYO, YUKON

A Feasibility Study of Geothermal Options

86-05598/

ERRATA NOTICE

The current issue of the HEAT PUMP OPPORTUNITIES FOR MAYO, YUKON report contains a number of errors, which are corrected in the following:

PAGE		CHANGE FROM	TO
10	Estimated Existing Oil Usage:		
	Community Club	$ 6,100	$ 6,500
	Curling Club	3,800	3,200
	Total Oil Estimated Usage	32,800	32,600
	Estimated Savings	22,700	22,500
12	Savings	22,700	22,500
31		$E = \frac{29.21 \times 8,278 \times 24}{71 \times 1} \times .75$	$E = \frac{29.31 \times 8,278 \times 24}{71 \times 1} \times .75$
31	Fuel Cost: Oil	11,407 x 0.55 = $ 6,075.00	11,738 x 0.55 = $ 6,455.90
	Difference Between Oil and Electricity	$ 4,677.0	$ 5,057.90
32	Fuel Cost: Oil	6,969 x 0.55 = $ 3,832.00	5,802 x 0.55 = $ 3,191.10
	Difference Between Oil and Electricity	$ 3,112.00	$ 2,471.10
34	Annual Fuel Oil Consumption:		
	Garage	3,066L	4,440L
	Total	14,376L	15,750L
37	Estimated Building Heat Loss:	142,900L	142,980L
49	Table 6.1 - amended as attached.		

Our apologies for any confusion which may have been caused by the original write-up.

HEAT PUMP OPPORTUNITIES

FOR MAYO, YUKON

A Feasibility Study of Geothermal Options

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Village of Mayo

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With a contribution from:

Remote Community Demonstration Program
of Energy, Mines and Resources Canada

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EXECUTIVE SUMMARY

The Village of Mayo, Yukon, currently uses a warm water well (18°C) to temper the village cold water well (1°C) to supply the village with domestic water. The water distribution piping of this northern village (63.6° lat. north, 135.9° long. west), is located in areas of permafrost, and although buried, is also subject to extremely cold winter weather (in excess of -50°C). The distribution of tempered water (8°C) appears to maintain water flow. Observations of the warm water well during sustained pumping indicate that more warm water than is needed for the village water system may be available for other uses. Since the population of Mayo (454) appears reasonably stable, additional warm water demand for the domestic system is not likely.

The Village of Mayo retained the services of Reid Crowther and Partners Limited, through a cost sharing program with Energy Mines Resources under funding available through the Remote Community Demonstration Program, to review the possibilities of heating buildings with any extra warm water which may be available. A comprehensive investigation of the ultimate geothermal capacity of the aquifer was not part of the study.

The study addressed a number of issues:

- review of well data
- location of major buildings
- types of existing heating systems
- retrofit opportunities
- cost of systems
- value of oil displaced
- other opportunities

The study identified two viable building scenarios for district heating:

- heating of five public buildings located along 6th Avenue;
- heating of the Judy Clarke School; .

utilizing heat pumps to boost the heating value of the warm water to extractable levels.

The building group which provided the best payback horizon based on the value of oil displaced was the 6th Avenue group, all of which could utilize heating coils placed on the return air side of the oil furnace of each building. A minimum capital cost requirement for this grouping of $117,000 was developed, which disposed of the heat pump discharge water into the village sewer system rather than using a re-injection well. Implementation of this minimum cost system will prove the validity of the heating capability and allow "hands-on" experience for the building operators. This grouping has an indicated payback period of less than 6 years, based on 1984 oil prices.

The Yukon Government has recently completed energy audits for the 6th Avenue group, and had documented the potential impact of conservation methods which would have less than a 5 year simple payback.

POSSIBILITÉS D'UTILISATION DE POMPES À CHALEUR À MAYO (YUKON)

Étude de faisabilité des options géothermiques

Résumé

Le village de Mayo (Yukon) utilise maintenant l'eau tiède (18°C) d'un puits pour augmenter la température de l'eau provenant du puits d'eau froide (1°C) qui sert à l'alimentation en eau du village. Le réseau d'approvisionnement en eau de ce village septentrional (63,6° de lat. nord, 135,9° de long. ouest), se trouve dans une zone de pergélisol, et même s'il est enterré, il est soumis à des températures très basses en hiver (dépassant -50°C). L'approvisionnement en eau à 8°C semble suffire pour assurer l'écoulement de l'eau dans les conduites. Des observations relevées sur le puits d'eau tiède pendant un pompage continu indiquent que le puits pourrait fournir de l'eau tiède pour d'autres usages en plus de subvenir aux besoins du réseau d'approvisionnement en eau du village. Étant donné la relative stabilité de la population de Mayo (454 h.), l'augmentation de la demande en eau tiède pour le réseau domestique semble peu probable.

Le village de Mayo a retenu les services de la firme Reid Crowther and Partners Limited pour examiner les possibilités de chauffer des locaux au moyen de l'eau tiède excédentaire. La recherche exhaustive du potentiel géothermique de l'aquifère ne faisait pas partie de cette étude.

L'étude a abordé les points suivants:

- examen des données sur le puits
- emplacement des principaux bâtiments
- types de systèmes de chauffage existants
- possibilités de réfection d'équipements
- coûts des systèmes
- valeur du pétrole remplacé
- autres possibilités

L'étude a déterminé deux scénarios possibles pour le chauffage de bâtiments dans le district:
- chauffage de cinq immeubles publics situés le long de la 6e Avenue,
- chauffage de l'école Judy Clarke,

avec exploitation de pompes à chaleur pour porter la température de l'eau chaude jusqu'à une température suffisante.

Le groupe de bâtiments qui offre les meilleures possibilités en matière de période de récupération, selon la valeur du pétrole remplacé, est celui de la 6e Avenue où l'on pourrait utiliser des serpentins de chauffage placés du côté retour d'air du calorifère à mazout dans chaque

bâtiment. Le coût en capital le plus bas obtenu pour ce groupe de bâtiments est de 117 000 $; il comporte la décharge de l'eau de rejet de la pompe à chaleur dans les égouts du village plutôt que dans un puits de réinjection. La mise en oeuvre de ce système à coût minimal prouvera la validité de la capacité de chauffage et donnera une expérience pratique aux exploitants des immeubles. La période de récupération pour le groupe de bâtiments serait inférieure à 6 ans, selon les prix du pétrole en vigueur en 1984.

Le gouvernement du Yukon a récemment procédé à la vérification des coûts énergétiques pour le groupe de la 6^{e} Avenue, et s'appui sur l'impact potentiel des méthodes de conservation pour dire que les coûts pourraient être amortis en moins de 5 ans.

Le village de Mayo a reçu pour la présente étude une contribution financière du Programme de démonstration dans les collectivités éloignées d'Énergie, Mines et Ressources Canada.

INTRODUCTION

The Village of Mayo (pop.454), located 56 Km east of the Stewart River crossing of the Klondike Highway, is situated on the flood plain of the Mayo River near the confluence of the Stewart River. The water supply system for the Village is comprised of a cold water well, a warm water well, pump house, reservoir and related pumps, valves and control components. Subject to both the extremes of cold weather and the location of the village water distribution system adjacent to large areas of perma frost, the village currently blends the warm water well water (18°C) with the cold water well water (about 1°C) to produce a tempered water supply of 7°C. This temperature is sufficient to maintain the security of the water supply system in spite of cold weather temperatures in excess of -50°C.

1.0 Warm Water Well

The warm water well intercepts a large gravel aquifer at a depth of about 244 metres. Under artesian pressure, the well has a surface free flow of about 3.5 L/S. With the installation of a down hole pump, flows of up to 12.6 L/S have been observed. Recently, the village swimming pool (240,000 litres) was filled directly from the warm water well using the down hole pump and a surface run 65 mm diameter firehose of over 240 metres, in 9 hours. From this, it is expected the well can sustain a flow rate of:

$$\frac{240{,}000 \text{ litres}}{9 \text{ hrs.} \times 60 \text{ min.} \times 60 \text{ sec.}} = 7.4 \text{ L/S}$$

against a flow pressure drop of approximately 200 KPa(240 metres at 0.85 KPa/metre). Observations by Village personnel indicated an increase in flow rate during sustained pumping which may be a result of gravel fines washed from the aquifer gravel immediately adjacent to the well casing by this pumping.

During the winter time, the warm water well is pumped together with the cold water well, and through manual adjustment of a 150 mm gate valve (about 1/2 open) on the warm water supply, a blended water temperature of 6.7°C is maintained to the village reservoir. The water level in the reservoir is controlled through floating level sensing devices.

At the current daily winter time water consumption of 635,600 litres, the following average flow rates apply:

$$\frac{635{,}600}{24 \times 60 \times 60} = 7.4 \text{ L/S of blended water (6.7°C)}$$

7.4 L/S of 6.7°C water is equivalent to
2.4 L/s of 17.8°C blended with
5.0 L/S of 1.1°C.

With an expected pumped water flow rate of 7.4 L/S available from the warm water well, 5.0 L/S (7.4-2.4) may be available on an average basis for alternate uses, without undue impact on current warm water usage. Village usage is not expected to increase.

A geological review of the warm water well is discussed in Appendix B.

2.0 Building Heating Concept

The availability of over 3.8 L/S of warm water (17.8°C) has attracted the attention of the residents of the Village of Mayo. In discussion with engineers at Reid Crowther & Partners Limited, and through the auspices of Energy Mines and Resources, Remote Community Demonstration Program, a study was initiated which would review the possibilities of a heat pump operation. The heat pump installation would boost the warm water well temperature of 17.8°C to approximately 43.3°C, and in conjunction with off-the-shelf hot water coil units, provide a source of heating for various buildings. (refer MS-1)

The use of a heat pump for this type of operation has been proven at many existing installations, and standard units are readily available.

The heat pump itself consists of components which are essentially identical to that of a household refrigerator - although of a larger size (detailed explanation is available in Appendix A: Heat Pumps). A refrigerant, such as Freon 22, circulates through an evaporator where the refrigerant gas is heated, then to a compressor to increase the pressure of the refrigerant gas, then through a condenser to cool the gas to a liquid stage, then through an expansion valve where rapid expansion of the refrigerant liquid to a gas decreases the gas temperature in much the same way as the gas from a propane bottle can freeze a person's hand. The cool gas is then warmed in the evaporator. Building heating would result from the installation of the condenser within the building heating system.

A general overview of a heat pump operation as it applies to a heating system is presented in MS1 (opposite) and MS2.(following)

These two alternative methods of building heating systems were reviewed.

- MS1 - installation of factory sealed unit with external water loop piping to a heating coil in the return air plenum.
- MS2 - installation of the condenser coil directly in the return air plenum.

The first method (refer MS1) although more expensive, was considered as a means of reducing the technical level of the installation contractor. However, in discussion with residents of the Village, it was determined that the second method (refer MS2) would be satisfactory. Since the existing furnaces will still be operational, the heating operation would revert to oil firing should the heat pump equipment fail.

Therefore in Mayo, heat would be taken from the warm well water by the refrigerant gas in a heat exchanger, then a compressor would pressurize the gas. Using the condenser coil, the building air (refer MS2) is heated as the refrigerant gas cools to a liquid. The expansion valve then rapidly expands the liguid from high pressure in the condenser to supply low pressure in the evaporator.

3.0 .. Mayo Heat Distribution

A number of available options exist for a heat distribution system:

- boost the temperature of the warm water at a central location, then distribute.
- distribute the warm water, and boost the warm water temperature at each building.(reference drawing M-1)
- cascade the system by boosting the warm water temperature at a central location, then provide an even higher temperature with a separate boost at each building.
- distribute the warm water, then use a heat pump at each building, with condenser coil in the furnace to draw heat from the water.(reference drawing M-2)

In the first three of the above options, hot water coils would be installed in or adjacent to the return air duct work existing in various buildings with hot air heating systems. In the fourth option, a condenser coil would be installed in the return air ductwork. However, for buildings with hot water heating systems, a water supply temperature of at least 60°C would be necessary which would, in turn, essentially dictate a double heat pump (cascade type) system.*

*Generally accepted practice will allow about 21°C to be added through a single heat pump.

The warm water would be supplied to the various building loads through an insulated double pipe system (supply and return), buried 1.8 metres in the ground. A 50 mm diameter pipe system will easily handle flows of 2.5 L/S and, with additional pump capacity, could handle flows up to 3.8 L/S. These flow rates will handle the preliminary demand estimates.

4.0 Heating Loads

A review of the main Mayo building locations (refer S-1 following) quickly determines a reasonable grouping of large heating loads; each group could be considered as an alternative.

These loads can be most easily summarized as:

Group A - located along 6th Ave;

- community club
- curling club
- firehall
- RCMP station
- new RCMP holding house
- hospital

Group B

- The Judy Clarke School

4.1 Group A

Group A is located in a linear fashion along 6th Ave., and could be easily serviced from a distribution system buried beneath 6th Avenue. However, a problem does becomes apparent as each building heating system is investigated. All the buildings noted except the hospital, are hot air heated which will permit the use of single stage heat pump to provide hot air distribution at about 43.3°C. At this preliminary stage, it is suggested that the hospital be eliminated.

Also, an assessment of the general heating loads for all the buildings*1, excluding the hospital, would develop a warm water flow demand of about 2.5 L/S.

To satisfy the heating demand for these buildings, it then becomes a matter of cost effectiveness and efficiency with respect to:

- a central heat pump heating plant, and hot water distribution at a temperature of 43.3°C.
- a central warm water distribution system, with individual heat pumps at each building.

Since hot water distribution (as opposed to warm water) at 207 KPa*2 will require a double piping system of metallic construction, couplings, connections and installation, warm water distribution through insulated plastic lines becomes the obvious selection - for ease of installation, to reduce installation costs and to allow for possible ground movement. Additionally, the use of individual heat pumps in each building eliminates the possibility of total system shut down should the central plant fail.

4.2 Group B

Group B is comprised of the school heating system which consists of 4 boilers which provide hot water both to wall mounted convection radiators and to hot water coils which are used to temper the air in the air handling system. As the forced air system only handles the make-up air requirements for the school, the main heating load is provided by the wall units. These wall units require hot water in the 60°C to 82.2°C range.

*1 refer to the design appendix for this analysis.

*2 the pressure is required to overcome the fluid friction within the piping system.

To supply such a hot water system, a cascade system consisting of either:

- warm water boost at the warm water well, then to distribution, and then additional boost at the school, or
- cascade warm water heating system to provide 60°C water, located at either the pump house or at the school.

Once again, the costs attendent to a pressurized hot water system will direct the selection toward a warm water piping system of insulated plastic construction.

4.3 System Summary

A brief summary of the existing building heating systems follows:

Group A Buildings -(1983 data when available)

Community Club

- 2 - 73.2 kW Airco furnaces
- floor area 306 sq. metres
- current oil usage (1983) is 11,738 litres
- electrical usage (1983) is 3796.52 kWh

Curling Club

- 1 - 45 kW Airco furnace
- floor area (excluding ice sheets), 222 sq. metre
- current oil usage, 5832 litres
- electrical usage, 2745.49 kWh

Firehall

- 1 - 73.2 kW Airco furnace
- 1 - 36.6 kW Haleco (office area)
- 1 - 35 kW Airco (maintenance area)
- floor area 418 sq. metres
- current oil usage 17,396 litres (has since been reinsulated)
- current electrical usage - not established

RCMP Station

- 2 - 55.6 kW Olsen Duomatic
  1 - 36.6 kW Olsen Duomatic (garage only)
- floor area 613 sq.metres(2 storey) - garage only 52 sq.metres
- current oil usage - 11,310 litres (1982)
- current electrical usage 2333.8 kWh

RCMP Holding House

- 2 - 33.4 kW Airco furnaces
- floor area 214 sq.metres
- current oil usage (new installation)
- current electrical (new installation)

Group B - Judy Clarke School

- 4 - 558 kW Superhot, hot water boilers
- floor area (including gym) approx. 3160 sq.metres
- current oil usage, 142,899 litres
- current electrical usage 29952.59 kWh

More detailed review of the various heating systems is included in Appendix A.

5.0 Distribution System

As discussed in the previous section, the selection of the piping system for water distribution is directed toward insulated plastic piping. This type of construction has been utilized on all recent water system installations in MAYO, and has proven to be an efficient and cost effective construction system. Local contractors are experienced with this type of piping system, with both fittings and replacement connections readily available. Also of significance is the ability of the piping system to absorb shock situations which may result from ground movement caused by frost heaving, or by wheeled or tracked equipment operating in the immediate or adjacent area.

Standard corporation stops will be used to connect each building to the supply/return pipes, with lead-ins to buildings completed in a similar fashion to the town water system. Each building connection will be metered to provide for system monitoring and billings for the thermal units utilized. Funds received for the warm water usage can then be used to retire the debt associated with the capital costs of both the distribution and the heat pump installations. Copper piping, currently utilized for water distribution within buildings, does not appear adversly affected by the geothermal waters.* Heat pump water connections would also be of copper piping construction.

6.0 System Costs

Details of equipment selection, and the cost associated with both the purchase and installation of the equipment for each building and detailed in Appendix A and summarized in tables 6.1 and 6.2. These costs are summarized as follows:

* refer to Appendix B for warm water chemical analysis.

6.1 Group A - Capital Costs

- distribution costs - 183 m @ $82/m $15,000
- building costs

community club	20,000	
curling club	12,000	
firehall	24,000	
RCMP station	28,000	
RCMP holding	19,000	
		103,000

- injection well (estimate only) 17,000

Total Capital Costs $135,000

Group A - Operating Costs

- additional yearly electrical load/cost to operate heat pumps (instead of oil use)

community club	8 tons	$1,400
curling club	3 tons	700
firehall	8 tons	2,500
RCMP station	8 tons	1,800
RCMP holding	5 tons	1,200
Additional Building Electrical Cost		$7,600

- Use of 11.2 kW downhole pump (in addition to existing use) estimated at one half of 4380 hours ($\frac{4380}{2}$ x 11.2 kW x $.1/kWh) = $2500 $2,500

Total estimated additional electrical $10,100

- estimated existing oil usage

community club	$6,100
curling club	3,800
firehall	8,100
RCMP station	8,700
RCMP holding(est.)	6,100
Total Oil Estimated Usage	$32,800
Estimated Savings	$22,700

It is estimated that continuous operation of the heat pumps will displace the interrupted oil firing cycle of the existing 65% efficient hot air furnaces.

6.2 Group B - Capital Costs

•	distribution costs 152.4 m at $82/m	$12,500	
•	School costs (cascade system)		
	heat pump 1	30,000	
	heat pump 2	45,000	
	installation	24,500	
•	reinjection well (estimate only)	$17,000	
	Total Capital Costs		$129,000

Group B - Operating Costs

•	additional electrical load/cost to operate heat pumps	$18,420
•	use of 11.2 kW downhole pump (in addition to existing use)	$ 2,500
	Additional Electrical Costs	$20,920
•	estimate existing oil usage	$78,640
	Indicated estimated saving *	$57,720

However, the heat pump system would not necessarily be able to displace the entire amount of oil used. In fact, the actual displacement could range from only 20% (compared to installed capacity) to nearly 100% (estimated demand load).

* to accurately assess the potential savings of a heat pump operation, a detailed computer energy analysis on the school building envelope will be required. Although an analysis of this detail is beyond the scope of this report, it appears the installed heating capacity is quite in excess of the expected demand load.

7.0 Payback Summary

Payback period for the heat pump installation is calculated based on a real interest rate of 5%, which is derived from estimated dollar cost increases of 12%, inflation escalation of 7%, 1984 dollars. Costs are rounded off.

Group A

- payback period for
  capital costs: $134,000
  savings: $ 22,700
  interest rate: 5%

  calculated payback is 7 years

Group B

- payback period for capital costs: $129,000
  savings: $9,540
  interest rate: 5%

  calculated payback is 21 years(estimate only)

Discussions held at the public meeting in Mayo, Sept. 13, 1984, indicated a possibility of discharging the warm water through the heat pumps, to the sewer collection systems. This would reduce the initial costs of the heat pump system by eliminating the re-injection well, and would provide an opportunity to "prove" the system for less cost.

8.0 Opportunities

A number of observations and comments have resulted from the on-site investigation of systems currently utilized within the Village of Mayo, from other completed upgrade Reid Crowther retrofit activities, from the knowledge of new heating alternatives which are under development, and from observations of alternative building systems which are available. These comments are grouped into the following general catagories:

- existing heating systems retrofit
- existing furnace upgrade opportunities
- new heating alternatives
- ice machine - alternate brine cooling
- YTG building - cooling system

8.1 Existing Heating Systems and Retrofit

During the on-site investigation of the existing heating systems of selected buildings in Mayo, a number of observations were made. The following text describes the existing heating systems, and suggests maintenance/repair items which could increase the efficiency of the systems.

Community Hall

The building is presently heated by two Airco Lo-Boy series oil fired furnaces with a total 88 kW heating capacity. Air is supplied through distribution ductwork in the crawl space and then discharged through floor grilles. Return air is ducted to 3 small return floor grilles (total grille area 0.41 m2). Return air duct is 840 mmx 250 mm(0.21 m2). Although no publication data from Airco is available to identify the air flow quantity, Reid Crowther established the air volume by checking the static pressure (50 Pa),measuring electric current drawn by the motors and measuring fan pulley sizes to estimate the air quantity. The estimated air flow is approx. 1230 L/S. This estimate applies when both fans are operating. The return air duct velocity is about 11.5 m/s (a rather high velocity) which means a 112 Pa pressure drop per 30 m of ductwork. The fans furnaces are not designed to handle this much pressure drop, which proves out the observation by the building operator that the furnace door has to be opened or the furnace will rumble.

Our recommendation for the return air problem is to cap off the return air duct and install new return air plenum and duct to furnace room wall with a return air grille. The existing rifle target range openings could be used as return air opening to pull return air through the crawl space. New return floor grilles can be simply installed by cutting the floor at suitable locations into crawl space. The heat pump installation includes a 8 T.R. refrigeration machine with condenser coil located at the existing furnace fan access opening. Access panels will need to be installed to allow access to existing fans and motors. A new 2 stage thermostat will provide lst stage control to the refrigerant circuit, and the 2nd stage to fire the existing furnaces. The furnace fan motor will need to be increased to 0.37 kW in order to pick up the additional pressure drop through the new condenser coils.

Curling Club

The curling club heating furnace is an Airco oil fired furnace with 454 kW heating capacity. Supply air is ducted within the crawl space and discharged through floor grilles. There are three return air openings in the furnace room (one at high level and two at low level) with fire dampers. (The fire dampers are installed upside down) Return air is drawn along the stair well and through return air openings back to the furnace. The proposed heat pump unit would be installed in the storage room adjacent to the furnace room and piped to a new condenser coil at the furnace. A new sheet metal return air plenum and ductwork is required to combine the two existing return air openings in the furnace and allow for the installation of one coil.

Temperature control will again be by two stage thermostat, similar to the one described for the Community Hall.

Firehall

The heating system consists of 3 oil fired Airco furnaces. One for the office area (37 kW), one for the firehall (73 kW) and the remaining one for the repair bay which was the old liquor store (33.7 kW). Both the office and hall furnaces supply air through the crawl space with floor grilles, and return the air at the ceiling. The repair bay furnace supply ductwork is located at low level with supply grilles and return air at high level. Observations indicate all furnaces are well maintained and are in good operating condition, with the exception of the repair bay furnace flue which has rust problems. The space thermostat for this furnace is set at 10°C and we suspect due to the limited operation of this unit, condensation in the flue is the main cause of the rust problem.

The heat pump would be located above the roof of the furnace room with a separate condenser coil installed in each furnace return air plenum. A number of observations apply to the repair bay area. These are:

- there is tremendous leakage in the repair bay area through the overhead folding door and broken windows. It is recommended that a tight seal and insulated door be installed, and that the window be blocked out to avoid any unnecessary heating load.

- The supply ductwork should be repaired to provide more uniform air flow.

All the furnace fan motors will need to be increased to one size larger in order to allow for the additional pressure drop through new condenser coils.

RCMP Station

There are 3 - Olsen oil fired furnaces for the office, residence and the garage. With a total heating capacity of 145 kW air distribution is installed as a conventional residential house with supply ductwork in basement, discharge through floor grilles, with the return air drawn back to units through the joist space. The garage unit has a supply cowl with return air drawn through the unit return openings.

The heat pump unit could be located at a corner within the garage with distribution refrigerant piping to each furnace condenser coil located in the return air plenums. An acoustic jacket is required for the heat pump unit in order to reduce the noise level.

RCMP Holding House

This new building was still under construction when the investigation occured. Two Airco oil fired furnaces were installed with a total heating capacity of 67 kW. One serving the office area and the other is for the holding area. Supply air ductwork is under the slab, with return air picked up at ceiling level.

The proposed heat pump unit could be located in the oil storage tank shed outside the main building. Due to the limited space in the shed, the heat pump would need to be elevated with a steel support structure above the existing oil tank. Refrigerant piping would be run within the suspended ceiling space in the building, to condenser coils located in each furnace return air plenum.

MAYO School

The heating system in the school consists of 4 - oil fired boilers providing hot water to wall radiation circuits, and three outdoor air handling units. The heating water temperature is controlled by temperature regulating thermostats, by an outdoor temperature sensor, and the staging of the boilers. The heating water pumping arrangement is through 2 pumps, one pump rated at 26.8 L/S while the other is rated at 47.3 L/S.

The proposed heat pump system for the school is a cascade system using 2 heat pump units. The first unit would draw 2.5 L/S of 18.3°C water, and through the heat pump process, produce 4.1 L/S of water at 37.7°C. Then, the second unit would utilize the 4.1 L/S 37.7°C water, and through the heat pump process again, produce 5.4 L/s of 60°C water. While 60°C water will not maintain the peak winter season load, it will relieve part or most of the mild season heating requirement. The system would not be used when water temperatures higher than 60°C are required to satisfy the heating loads.

From the one site observations, it would appear the existing pumping arrangement is designed for a dual range pumping operation. However, with only one check valve installed on the large pump circuit, a short circuit problem could occur with water circulating back through the small pump, thereby reducing the flow under high demand requirements.

8.2 Existing Furnace Upgrade

Community Hall and Curling Club

The existing furnaces showed signs of insufficient maintenance. Fan access panels were left open and filters were not installed. Rust patches on gas flues indicated excess condensation. The upgrading of existing furnaces should included:

- the furnaces should be vacuum cleaned throughout.
- filters should be installed and replaced regularly.
- fan belts should be checked, belt tension adjusted regularly.
- gas flues should be replaced and the new flues wrapped with fibreglas insulation to reduce the amount of condensation.
- presently, the furnace rooms are also used as storage facilities. All the stored materials should be removed from the furnace rooms to reduce fire hazards.

Fire Hall

The existing furnaces appeared in satisfactory operating condition with the exception of the Service Bay unit. The gas flue of this unit showed gas flue rust patches caused by condensation. The gas flue should be replaced and the new flue should be wrapped with fibreglas insulation.

RCMP Station and Holding House

All furnaces are in good operating condition with no upgrading necessary.

General Comments

Periodically check and adjust oil burner nozzles, fan belts, temperature controllers as well as the replacement of filters. This will prolong the equipment service life and limit the occurrence of failure. Regular maintenance to heating equipment is essential to provide a comfortable environment, maintenance of operating efficiency and prevention of excessive consumption of fuel.

A program of insulation retrofit/upgrade is currently underway which will certainly reduce the amount of heating oil used. Attention is also being given to leaky (drafty) doors and windows by the installation of weather stripping and caulking.

8.3 New Heating Alternatives

One quite exciting venture into furnace development is called the "pulse" furnace. This concept involves the mixing of a small quantity of fuel with the exact stochiometric (or ideal) requirement of combustion air, and then the ignition of this pulse of fuel/air. The resulting combustion is explosive in nature and extremely efficient resulting in the production of a small quantity of water and carbon dioxide and heat. The explosions are so small and frequent that the furnace sounds much like a small air compressor. The furnace requires only a small plastic drain line to discharge water formed during combustion and a small plastic vent line for the carbon dioxide.

At the present time, this concept has been developed for the use of gaseous products only, such as natural gas and propane.* Thermal efficiencies of this furnace reach 97% compared to existing conventional furnaces which have efficiencies ranging from 50 to 60%, for well maintained furnaces.

*This type of system will be relevant to the new propane installation at the hospital.

8.4 Ice Machine - Alternate Brine Cooling

The existing ice plant is equipped with a 14.9 kW Dunham Bush compressor unit which has an air cooled condenser. Brine is cooled by pumping through the evaporator, then distributed to the ice rink cooling circuits for ice making purposes.

An alternate cooling principle would be to utilize the cold winter climate in Mayo. A dry cooler (brine coil with an electrically driven fan) would draw cold outdoor air across the cooler with circulating brine within the cooler tubes. A set of control valves would divert the brine from ice rink to the dry cooler and by-pass the evaporator. This will eliminate the compressor in some of the curling season. A temperature sensor in the brine circuit would constantly monitor the brine temperature and should the temperature drop below the required set point, the dry cooler circuit will completely deactivate and return the flow of brine to its normal circuit. Freeze protection would be required to protect the dry cooler when the brine flow is stopped. This may take the form of measuring the concentration of the brine (with some subsequent reduction in system cooling capacity) or the installation of dampers and special controls on the dry cooler.

8.5 YTG Building - Cooling System

The most cost effective cooling system for the YTG Building will be the installation of a Direct Expansion (DX) cooling system in the existing air handling equipment. The system would consist of a DX refrigerant coil, and an outdoor air cooled condensing unit located on roof. The outdoor air cooled condensing unit is self-contained, factory pre-wired for power and control circuits. The advantages with this system are:

- minimum disturbance to existing equipment
- re-use of all the existing distribution ductwork

A skilled mechanic will be required to install the refrigerant piping between the DX coil and the air cooled condensing unit.

The alternative would be to install a roof-top combined cooling and air handling unit. Again the unit would be self-contained including supply fan, DX cooling coil, compressor, condenser coil and factory pre-wired power and control circuits. The complete unit would be lifted to the roof, and with the connection of an electric power supply, would be ready to operate. Supply ductwork from the roof top unit would be connected to the existing supply riser in the duct shaft with a motorized control damper. A separate control damper would also be required at the discharge ductwork of existing air handling unit. When the roof top unit is in operation, the top control damper would open, the damper in the basement would close.

Both systems require mechanical equipment located on roof. It is recommended that the building structural engineer be consulted to see if any additional structural reinforcing may be necessary.

9.0 RECOMMENDATIONS AND CONCLUSIONS

The investigations carried out for this report have defined a feasible heating system which uses the Mayo warm water well in conjunction with heat pumps to supply the heating requirement for buildings in Mayo. Specific recommendations and conclusions are defined in the following text.

9.1 Recommendations

A number of items should be addressed to establish a firm basis upon which to assess the warm water distribution and utilization effectiveness.

First, and foremost, the warm water well requires an extended duration pumping test to define the capacity of the well acquifer, and the thermal capacity of the geothermal source. This test should be carried out over at least a two day period to prove the well capacity of at least 7.4 L/S and a delivery temperature of 18°C. Should the well temperature decline, during the pumping test, an assessment of the thermal capacity will have to be made to define the extent to which the warm water well can be used.

After "proof" of the warm water well is established, the heat pump system can easily be retrofitted to the existing oil fired furnaces. Disposal of the warm water to the village sewer system will reduce the initial capital cost of the heating distribution system, and will allow the building operators to become familiar with the heat pump system operation.

Geophysical investigations should be carried out to determine the probable extent of the geothermal area, the likelihood of additional warm water availability, and the temperatures which may be available.

Although corrosion of distribution piping is not expected to be a problem, monitoring of the piping system (especially the copper piping within the buildings) should occur.

An energy study to identify the actual heating requirements of the Judy Clarke school (as opposed to the installed capacity) will help define the amount of oil which may be displaced. A warm water/heat pump system may provide a significant amount of the heating requirement for the school. The oil fired equipment can then be used to "top-up" the amount of heat required during extremely cold days.

Weekly data logging of the warm water/heat pump system should be maintained during the first year of operation to establish a data base which may be used for other heating systems within the Mayo area.

9.2 Conclusions

From the information presented within this report, it is apparent that the use of the warm water augmented through heat pump utilization is indeed viable for building heating. The heat pump units identified for installation are standard "off-the-shelf" components and are well proven. The retrofit of existing heating systems to incorporate the use of heat pumps is not difficult and leaves each oil furnace fully operational on oil fire in the event of warm water distribution or individual heat pump failure.

An effective recovery of capital cost for the five buildings along 6th Avenue will occur in less than six years based on the expected displacement of fuel. During isolated incidents of extreme cold, the use of oil firing will automatically supplement the available heat pump energy.

The Judy Clarke school is heated through circulating hot water at a temperature which will dictate the use of two heat pump loops installed in series. This will elevate the warm water temperature to the existing school distribution temperature. However an estimate of oil displaced and payback cannot be made until an accurate energy audit of the school determines the heating demand load.

APPENDIX A

TECHNICAL SUMMARY

.1 Heat Loss Estimation

.2 Group A

.3 Group B

TECHNICAL SUMMARY

.1 Heat Loss Estimation

.1 Heat Loss Estimation

The following building heat losses are estimated by the Degree Day procedure as published by ASHRAE in Chapter 28 of the 1981 Fundamental Handbook. The current recommended formula is:

$$E = \frac{HL \times D \times 24}{t \times K \times V} \quad (CD)$$

Where E = fuel of energy consumption

HL = design heat loss including infiltration and ventilation

D = number of 18.3°C Degree days

t = design temperature difference

k = correction factor which includes the effects of the rated full load efficiency, part load performance, oversizing, and energy conservation device

V = the heating value of fuel

CD = empirical correction factor for heating affect vs 18.3°C Degree days

If the current fuel consumption is not available from the Village of Mayo, the heat loss estimation is based on the following assumptions:

- the existing installed furnace capacities with estimated operating efficiency
- the construction of the building
- the estimated infiltration and leakage

TECHNICAL SUMMARY

.2 GROUP A

TECHNICAL SUMMARY

COMMUNITY HALL

Estimated building heat loss = 29.31 kW
Annual fuel oil consumption = 11738 litres
Annual energy consumption - electric heat pump unit

$$E = \frac{29.21 \times 8278 \times 24}{71 \times 1} \times 0.75$$

$$= 61{,}520 \text{ kWh}$$

Heat pump COP = 4.5

The actual energy consumption = $\frac{61{,}520 \text{ kWh}}{4.5}$

= 13,980 kWh

Fuel Cost: Oil (@ $0.55 litre) 11407x0.55= $6,075.00
Electricity (@ $0.1/kWh) 13,980 x 0.1 = $1,398.00

Difference between oil and electricity = $4,677.00

Heat Pump Selection - Keeprite CCU-08 HW
Total Heat Rejection = 36.33 kW
Power Input = 8.2 kW
Source Water = 0.63 L/S

Equipment Cost:

Heat pump unit	$12,000.00
Heat pump installation	800.00
Coil 0.93 m^2	1,500.00
Thermostat	175.00
Source piping	1,200.00
Heat pump piping	800.00
Sheet metal (lab. & mat.)	1,200.00
Refrigeration controls	500.00
Circulating pump	600.00
Electrical (lab. & mat.)	800.00
	$19,575.00

CURLING CLUB

Estimated building heat loss = 15.44 kW
Annual fuel oil consumption = 5802 L
Annual energy consumption - electric heat pump unit

$$E = \frac{15.44 \times 8278 \times 24}{71 \times 1} \times 0.75$$

$$= 32{,}400 \text{ kWh}$$

Heat pump COP = 4.5

The actual energy consumption $= \frac{32{,}400 \text{ kWh}}{4.5}$

$= 7{,}200$ kWh

Fuel Cost:	Oil	(@ $0.55 litre)	6969x 0.55	= $3,832.00
	Electricity	(@ $0.1/kWh)	7200x 0.1	= $ 720.00

Difference between oil and electricity = $3,112.00

Heat Pump Selection - Keeprite CCU-03 HW

Total Heat Rejection	= 12.6 kW
Power Input	= 2.8 kW
Source Water	= 0.28 L/S

Equipment Cost:

Heat pump unit	$ 6,000.00
Heat pump installation	500.00
Coil 0.46 m^2	750.00
Thermostat	175.00
Source piping	1,500.00
Heat pump piping	800.00
Sheet metal (lab. & mat.)	400.00
Refrigeration controls	400.00
Circulating pump	600.00
Electrical (lab. & mat.)	800.00
	$11,925.00

FIRE HALL

Estimated building heat loss = 35.17 kW

Annual fuel oil consumption = $\frac{35.17 \times 8278 \times 24}{71 \times 0.45 \times 11.15} \times 0.75$

= 14710 litre*

Annual energy consumption - electric heat pump unit

$E = \frac{35.17 \times 8278 \times 24}{71 \times 1} \times 0.75$

= 73,692 kWh

Heat pump COP = 4.5

The actual energy consumption = $\frac{73,692 \text{ kWh}}{4.5}$

= 16,376 kWh

Fuel Cost: Oil (@ \$0.55 litre) 14710 x 0.55 = \$8,090.00
Electricity (@ \$0.15/kWh) 16,376 x 0.15 = \$2,456.00

Difference between oil and electricity = \$5,634.00

Heat Pump Selection - Keeprite CCU-08 HW
- Total Heat Rejection = 36.34 kW
- Power Input = 8.2 kW
- Source Water = 0.63 L/S

Equipment Cost:

Heat pump unit	\$12,000.00
Heat pump installation	800.00
3 - Coils 1.49 m^2	2,400.00
3 - Thermostats	525.00
Source piping	2,000.00
Heat pump piping	1,200.00
Sheet metal (lab. & mat.)	2,100.00
3 - Refrigeration controls	1,200.00
Circulating pump	600.00
Electrical (lab. & mat.)	1,200.00
	\$24,025.00

*Fuel consumption differs from system summary on Page 8. The oil usage of 17,396 litres was the consumption supplied from Mayo before the building was re-insulated. The 14710 litres consumption is the estimated energy consumption with new insulation.

RCMP STATION

Estimated station heat loss = 30.37 kW
Estimated garage heat loss = 7.33 kW

37.70 kW

Annual fuel oil consumption:

Station	11310 litres
Garage	3066 litres
Total	14376 litres

Annual energy consumption - electric heat pump unit

$$E = \frac{37.70 \times 8278 \times 24}{71 \times 1} \times 0.75$$

$$= 78{,}997 \text{ kWh}$$

Heat pump COP = 4.5

The actual energy consumption = $\frac{78{,}997 \text{ kWh}}{4.5}$

= 17,555 kWh

Fuel Cost: Oil (@ $0.55 litre) 15750x0.55 = $8,663.00
Electricity (@ $0.1/kWH) 17,555 x 0.1 = $1,755.00

Difference between oil and electricity = $6,908.00

Heat Pump Selection - Keeprite CCU-08 HW
Total Heat Rejection = 36.34 kW
Power Input = 8.2 kW
Source Water = 0.63 L/S

Equipment Cost:

Heat pump unit	$12,000.00
Heat pump installation	800.00
3 - Coils 1.67 m^2	2,700.00
3 - Thermostat	600.00
Source piping	2,500.00
Heat pump piping	2,800.00
Sheet metal (lab. & mat.)	2,200.00
3 - Refrigeration controls	1,600.00
Circulating pump	600.00
Electrical (lab. & mat.)	500.00
	$27,800.00

RCMP HOLDING STATION

Estimated building heat loss = 26.73 kW

Annual fuel oil consumption = $\frac{26.73 \times 8278 \times 24}{71 \times .45 \times 11.15} \times 0.75$

= 11,180 litres

Annual energy consumption - electric heat pump unit

$E = \frac{26.73 \times 8278 \times 24}{71 \times 1} \times 0.75$

= 56,006 kWh

Heat pump COP = 4.5

The actual energy consumption = $\frac{56,006 \text{ kWh}}{4.5}$

= 12,445 kWh

Fuel Cost: Oil (@ \$0.55 litre) 11180x0.55 = \$6,149.00
Electricity (@ \$0.1/kWh) 12,445 x 0.1 = \$1,245.00

Difference between oil and electricity = \$4,904.00

Heat Pump Selection - Keeprite CCU-05 HW
Total Heat Rejection = 21.4 kW
Power Input = 4.5 kW
Source Water = 0.38 L/S

Equipment Cost:

Heat pump unit	\$ 9,000.00
Heat pump installation	1,200.00
Coils 0.74 m^2	1,200.00
2 - Thermostats	350.00
Source piping	2,400.00
Heat pump piping	800.00
Sheet metal (lab. & mat.)	1,200.00
2 - Refrigeration controls	900.00
Circulating pump	600.00
Electrical (lab. & mat.) -	1,150.00
	\$18,800.00

TECHNICAL SUMMARY

.3 Group B

MAYO SCHOOL

Existing school heating system - 4 hot water boilers
Output - 2232 kW
2 circulating pumps provide 2 stage pumping arrangement @ 47.4 L/S and 30 L/S respectively

Estimated building heat loss based on 1983 fuel oil consumption (Degree Day Method) 142,900 L

$$H.L. = \frac{142,980 \times 11.15 \times 71 \times 0.5}{8278 \times 24 \times 0.75}$$

= 380 kW

The proposed heat pump system:

1st Unit

- Evaporator Capacity

  2.5 x 4.17 x 11.1°C t = 117.23 kW

- Heat Rejection

  117.23 kW x 1.3 = 152.40 kW (3.3 L/S)
  (at 37.8°C leaving water temperature)

- Compressor Power Input

  152.40 - 117.23 = 35.17 kW
  Heat Pump COP = 4.46

2nd Unit

- Evaporator Capacity

  3.3 L/S x 4.17 x 11.1°C t = 152.75 kW

- Heat Rejection

  152.75 kW x 1.3 = 198.57 kW
  (at 60°C leaving water temperature and 4.3 L/S)

- Compressor Power Input

  178.57 - 152.75 = 45.82
  Heat Pump COP = 4.33

The maximum capacity of the heat pump system is 4.3 L/S of hot water at 60°C.

MAYO SCHOOL (Continued)

Annual energy consumption - electric heat pump unit

$$E = \frac{380 \text{ kW} \times 8278 \times 24}{71 \times 1} \times 0.75$$

$$= 797{,}486 \text{ kWh}$$

Heat pump COP = 4.33

The actual energy consumption = $\frac{797486 \text{ kWh}}{4.33}$

= 184,177 kWh

Fuel Cost: Oil (@ $0.55 litre) 142,980 x 0.55 = $78,639.00
Electricity (@ $0.1/kWh) 184,177 x 0.1 = $18,418.00

Difference between oil and electricity = $60,221.00

However, and most importantly, without a good deal more investigation and calculation, the extent to which the heat pump system (supplying 4.3 L/S continuously) will meet the demand heating load of the school (estimated at 26.8 L/S on coldest days) cannot be estimated at this time. A payback calculation would be a guess.

Equipment Cost:

30 T.R. heat pump	$ 30,000.00
45 T.R. heat pump	45,000.00
3.3 L/S circulating pump	3,000.00
4.3 L/S circulating pump	4,000.00
4 - control valves	2,400.00
Heat pump shed	3,000.00
Electric heater 5 kW	1,500.00
Heat pump piping	6,750.00
Source piping	12,500.00
Heat pump installation	2,000.00
Electrical (lab. & mat.)	1,000.00
	$112,150.00
Plus Injection well	17,000.00
	$129,150.00

APPENDIX B

WARM WATER WELL

GEOLOGICAL REVIEW

APPENDIX B

Warm Water Well
Geological Review

EBA Engineering Consultants, Whitehorse, were retained by Reid Crowther to review available warm water well data, and provide comments directed toward a number of considerations. To complete the review of available data, EBA would attempt to access:

- original well logs and relevant observations
- data of other adjacent well information and/or drilling activities
- information of other wells in the same geological area (Stewart Crossing, Keno)
- water quality data
- aquifer characteristics
- geological mapping
- water temperature history
- artesian flow histories

Additionally, EBA would undertake discussions with government geologists to expand, to the extent possible, the quantity and quality of information.

The intent of this historical data review was to assemble comments which would provide meaningful statements toward:

- likelihood of a second well in the immediate vicinity which could possibly deliver flow rates at similar temperatures to the existing warm water well.

- possibility of higher temperature sources in the vicinity of the community.

- estimate of the life expectancy of the geotechnical well source under the additional flow conditions proposed within the heat pump section of the study (3.03 L/S).

- probable extent of the geothermal resource.

Although the extent of available information is not large, a number of both discussions and review activities were completed. From these assessments the following comments summarize the geotechnical review:

- the aquifer is likely quite large, and would extend throughout the Stewart River Valley, with the source likely upstream to the west, or north towards Keno. The water is located deep in glacial deposits, beneath the shallow discontinuous permafrost, and probably not too far above the bedrock.

- The water well data presented in the Hydrological Consultants Ltd. report of January 1980 indicates a flow rate of approximately 9.5 L/S was maintained over five hours, although problems with the well screen or the packer were identified. It is felt that 150 Igpm is a reasonable estimate of long term yield. The chemical analysis of the water was determined by:

  Western Industrial Laboratories Ltd. for Hydro Geological Consultants Ltd. Report Number 296-253 for Mayo (sample taken Oct. 11, 1975) is -

PH	8.13	
Total dissolved solids	390 ppm	
ignition loss	100 ppm	
	ppm	Epm
Sodium - Potassium	59	2.57
Calcium	42	2.1
Magnesium	22	1.81
Carbonate (CO_3)	-	-
Bicarbonate (HCO_3)	288	4.72
Alkalinity (total as $CaCo_3$)	236	--
Sulfate (SO_4)	78	1.62
Chloride (Cl)	5.0	0.14
Total Hardness as Calcium Carbonate	195	---
Iron (Fe)	.18	---
Fluoride (F)	.18	---

- as the existing warm water well appears to be near the depth of bedrock, it is expected that higher temperatures may not be available.

- cooling of the aquifer may become evident after prolonged pumping but insufficient data exists to resolve this issue.

To respond to the questions of both long term performance and aquifer capacity, additional testing will be required. These tests are:

- longer term pumping tests of the warm water well (at least 48 hours)
- continuous temperature measurement of the water
- measurement of draw down effects of the pumping test

To define costs associated with the additional testing, Midnight Sun Drilling Co. Ltd. was contacted. The estimate of costs provided was:

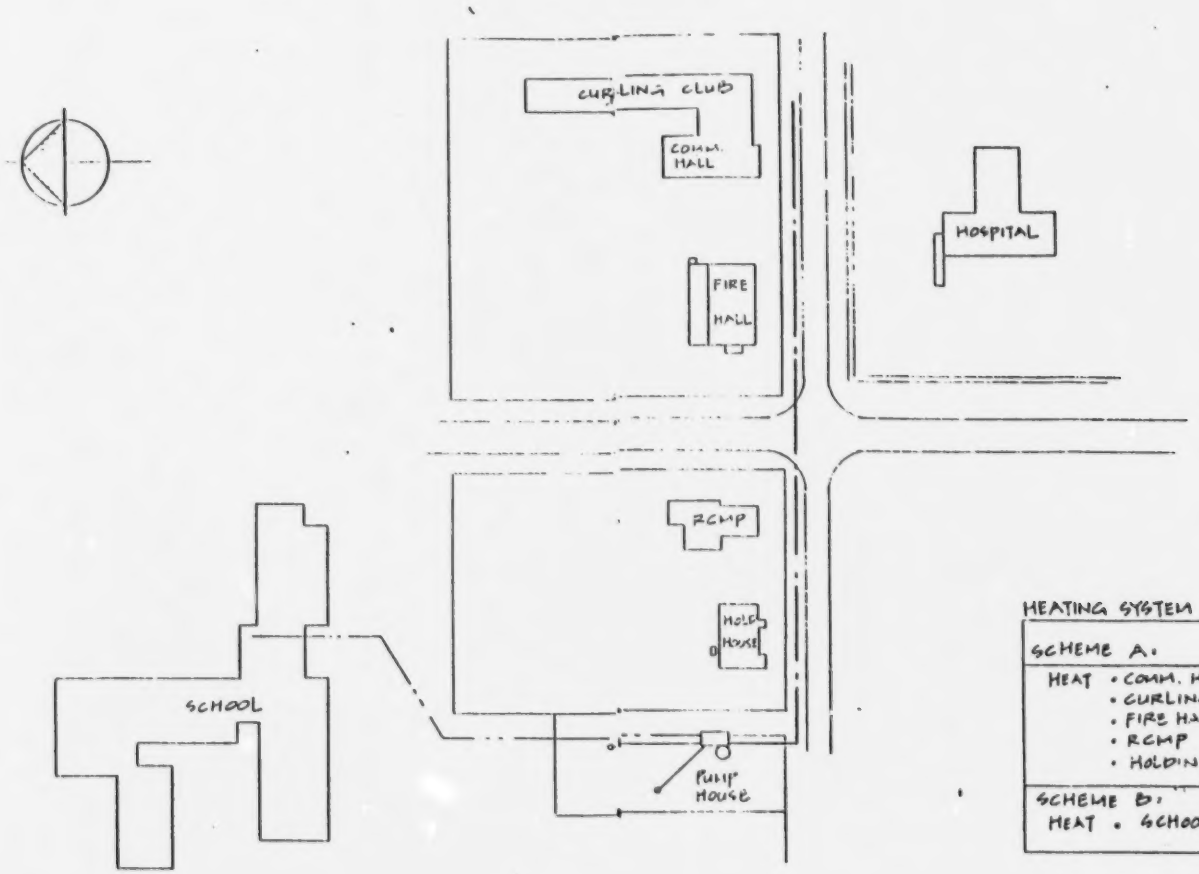
mobilization and return	$1110.
test equipment	1024.
misc. material	246
labour	3620
Total estimated costs for 48 hour test	$6000

To increase the length of the test beyond 48 hours, the increase in costs would be:

72 hours total test	$1000
96	$2000
168	$5000

It is recommended that a 48 hour pump test be initiated, as a minimum, to provide the additional data which is needed to respond to the questions of long term performance and aquifer capacity. This test should proceed prior to project implementation.

Once the proposed system A has been proven operationally, and proof of well capacity has been attained through flow monitoring (equipment available at pumphouse but in need of repair and installation) additional loads can be added.



HEATING SYSTEM ALTERNATIVES

SCHEME A:	FLOW RATE	DIST.
HEAT • COMM. HALL	10 GPM	600'
• CURLING CLUB	4.5 GPM	530'
• FIRE HALL	10 GPM	400'
• RCMP	10 GPM	200'
• HOLDING HOUSE	6 GPM	100'
SCHEME B:		
HEAT • SCHOOL	40 GPM	500'

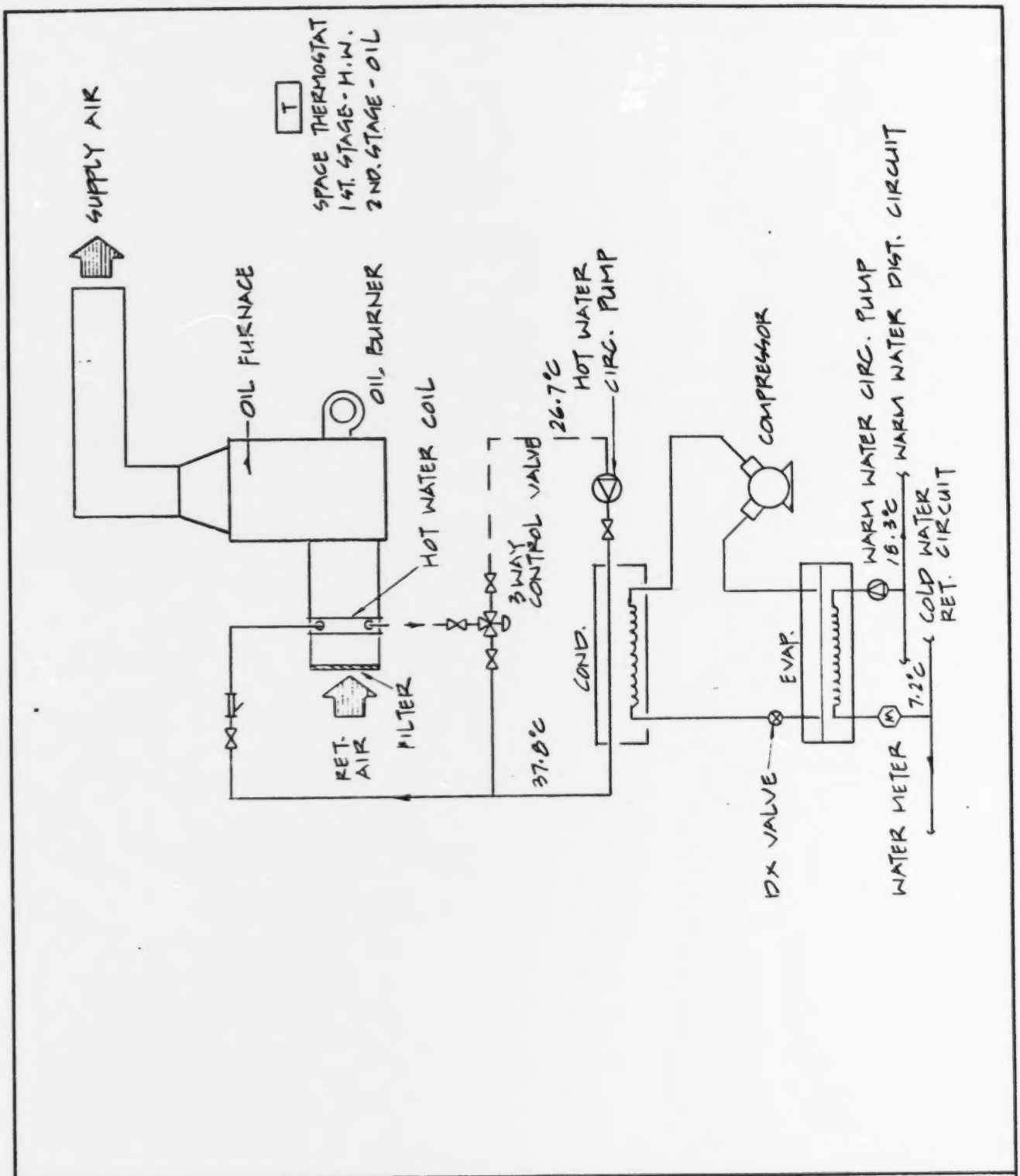
SITE PLAN

date	revision	app

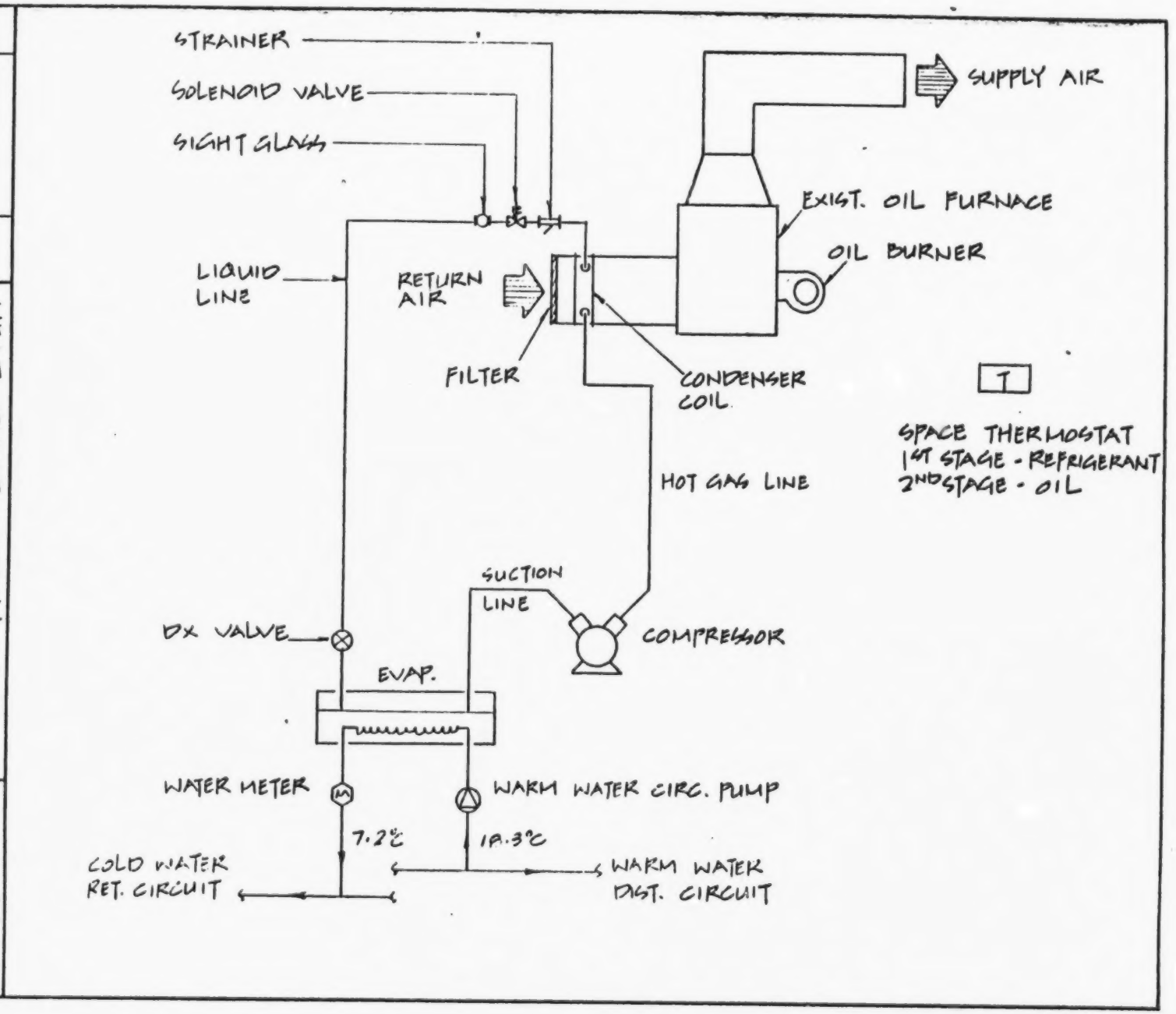
WARM WATER HEATING
MAYO, YUKON

REID, CROWTHER & PARTNERS LIMITED
consulting engineers and planners

des RS	dwn WC
ckd	app
date Sept. 13/67	
scale 1" = 100'	
proj no 29025	
dwg no S-1	rev



			HEAT PUMP INSTALLATION HOT WATER LOOP MAYO, YUKON	SCALE N.T.S DATE SEPT. 13/82 DES WC DWN CKD APP PROJ. NO. 29015
			Reid Crowther & Partners Ltd. Engineers • Planners • Scientists Vancouver • Kelowna • Calgary • Red Deer Edmonton • Lethbridge • Saskatoon • Regina Winnipeg • Ottawa • Yellowknife • Whitehorse Reid Crowther	DWG. NO. MS-1
DATE	REVISIONS	APP		



DATE	REVISIONS	APP

HEAT PUMP INSTALLATION
DIRECT EXPANSION
MAYO, YUKON

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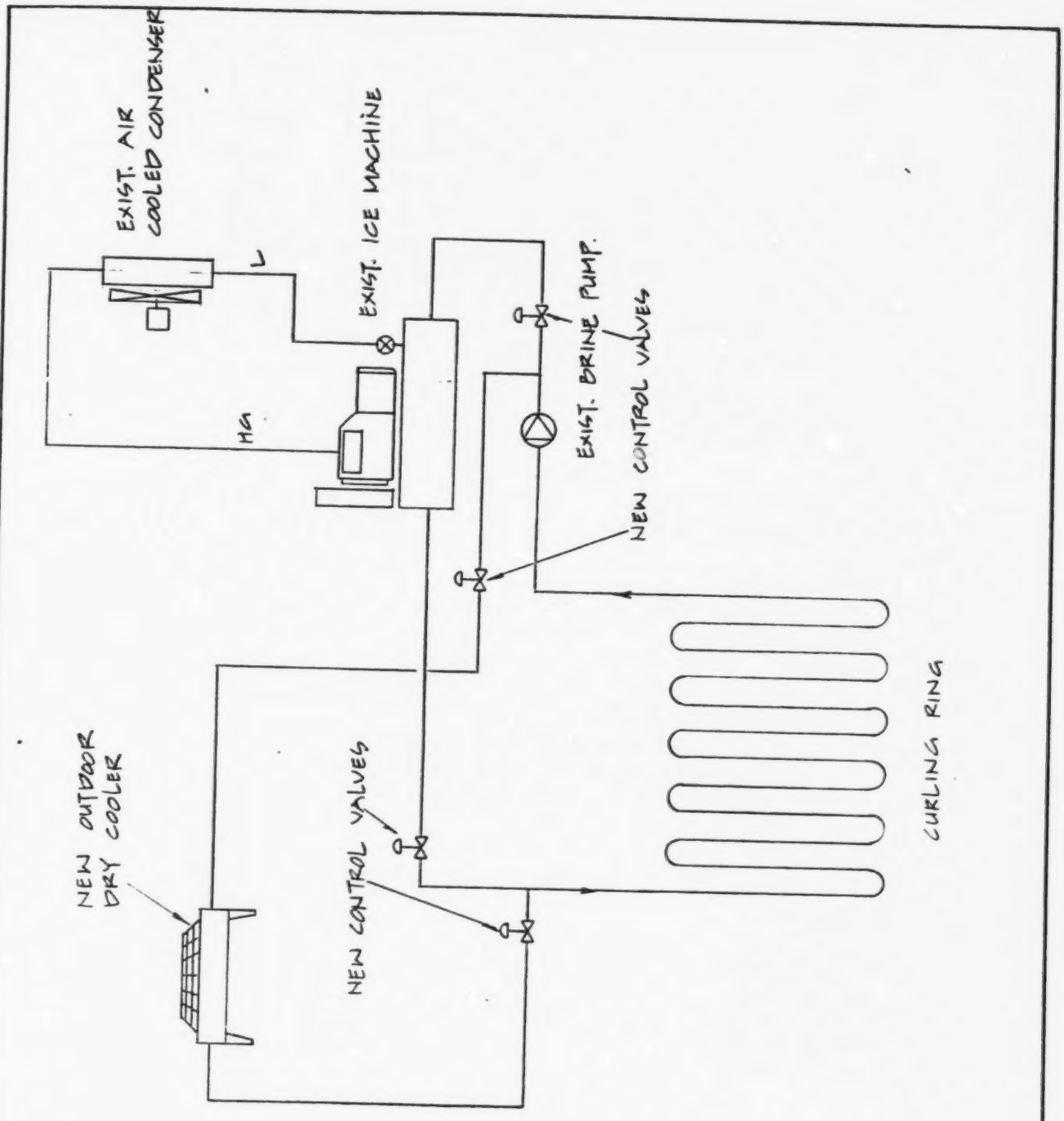
Edmonton • Lethbridge • Saskatoon • Regina
Winnipeg • Ottawa • Yellowknife • Whitehorse

Reid Crowther

SCALE N.T.S
DATE SEPT. 13/84
DES WC DWN
CKD APP
PROJ NO 29015

DWG NO. MS-2



DATE	REVISIONS	APP

CURLING CLUB - ICE MACHINE ALTERNATE COOLING
MAYO, YUKON

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Edmonton • Lethbridge • Saskatoon • Regina
Winnipeg • Ottawa • Yellowknife • Whitehorse

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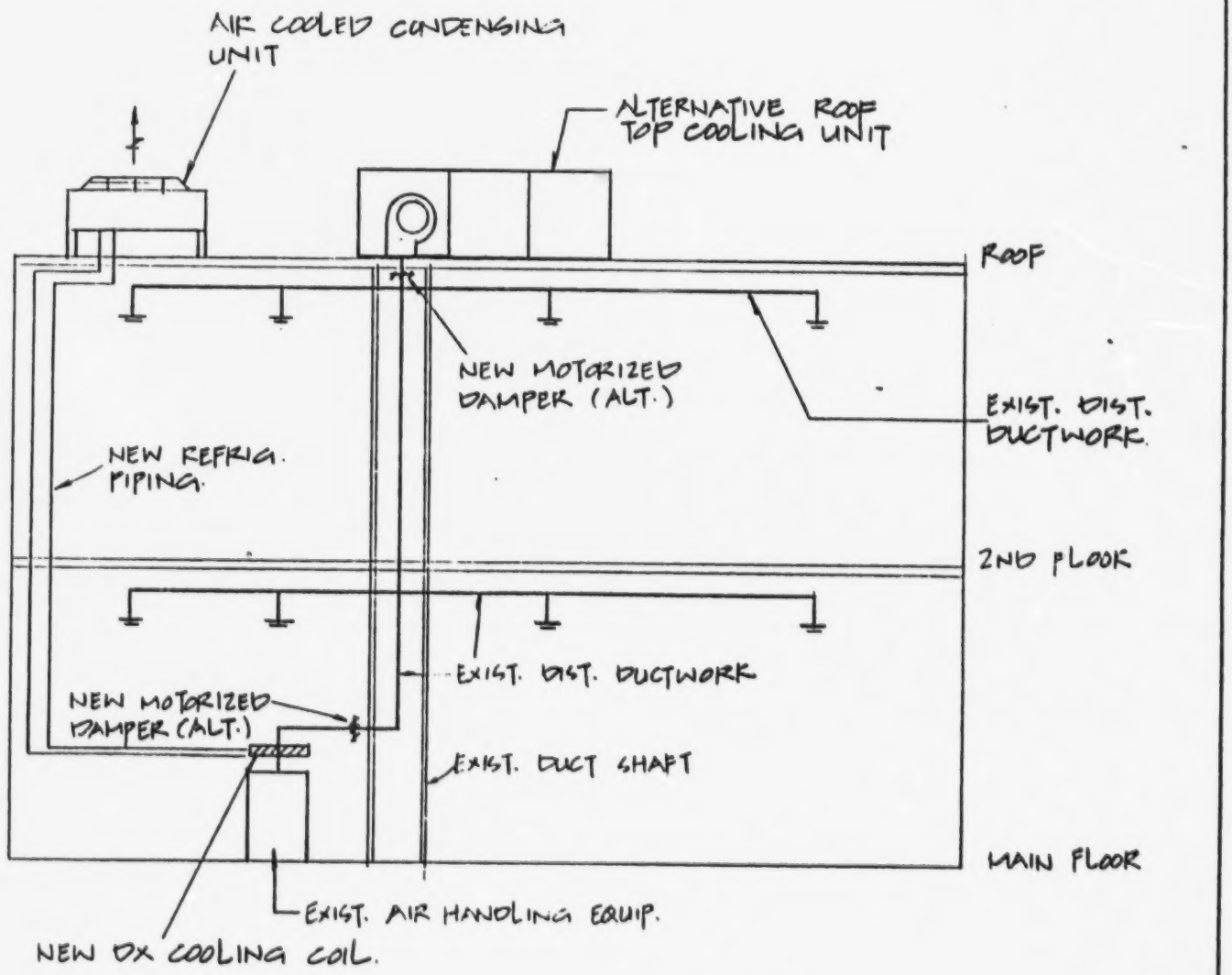
SCALE N.T.S
DATE SEPT. 13/87
DES WC DWN
CKD APP
PROJ NO 29015

DWG NO.
MS - 3



SYSTEM SCHEMETIC

DATE | REVISIONS | APP

YTG BUILDING
COOLING SCHEMATIC
MAYO, YUKON

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Winnipeg • Ottawa • Yellowknife • Whitehorse

Reid Crowther

SCALE N.T.S.
DATE SEPT. 13/84
DES WC DWN
CKD APP
PROJ. NO 2901.5

DWG. NO.
MS-4

TABLE 6.1 - GROUP A

BUILDING	HEAT PUMP	THR (KW)	SOURCE WATER	OIL COST	ELECT. COST	SAVING	EQUIP. COST
COMMUNITY HALL	08	36.3	0.63 L/S	$6456	$1398	$5958	$19575
CURLING CLUB	03	12.6	0.28 L/S	$3191	$720	$2471	$11925
FIRE HALL	08	36.3	0.63 L/S	$8090	$2456	$5634	$24025
RCMP STATION	08	36.3	0.63 L/S	$8663	$1755	$6908	$27800
RCMP HOUSING	05	21.4	0.38 L/S	$6149	$1244	$4904	$18800
		142.9	2.55	$32549	$7574	$24975	$102125

INJECT WELL - $17000

183 m DIST.
PIPING. $82/m - $15000

$32000

RUNNING COST
OF DOWNHOLE PUMP - $2500

TOTAL COST. - $134,125

TOTAL SAVING - $22475

PAYBACK - 7.0 YEARS AT 5% ANNUAL INTEREST COMPOUNDED MONTHLY

DATE | REVISIONS | APP

GROUP A
HEAT PUMP
SYSTEM COSTS

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SCALE
DATE
DES ____ DWN ____
CKD ____ APP ____
PROJ. NO. 2901.5

DWG NO.
TABLE 6.1

TABLE 6.2 - GROUP B

BUILDING	HEAT PUMP	THR (KW)	SOURCE WATER	OIL COST	ELECT. COST	SAVING	EQUIP. COST
MAYO SCHOOL	30 & 45	248	2.5 L/S	$78639	$18418	*$12044	$99650

* SEE TEXT ON PAGE 11 & A.7 OF TECHNICAL SUMMARY (20% OF SAVING ALLOWED)

INJECT WELL - $17000

152 m EST.
PIPING $82/m - $12500

$29500

RUNNING COST
OF DOWNHOLE PUMP - $2500

TOTAL COST. - $129,150

NET SAVING - $9544

PAYBACK - 21.2 YEARS.

DATE | REVISIONS | APP

GROUP B
HEAT PUMP
SYSTEM COSTS

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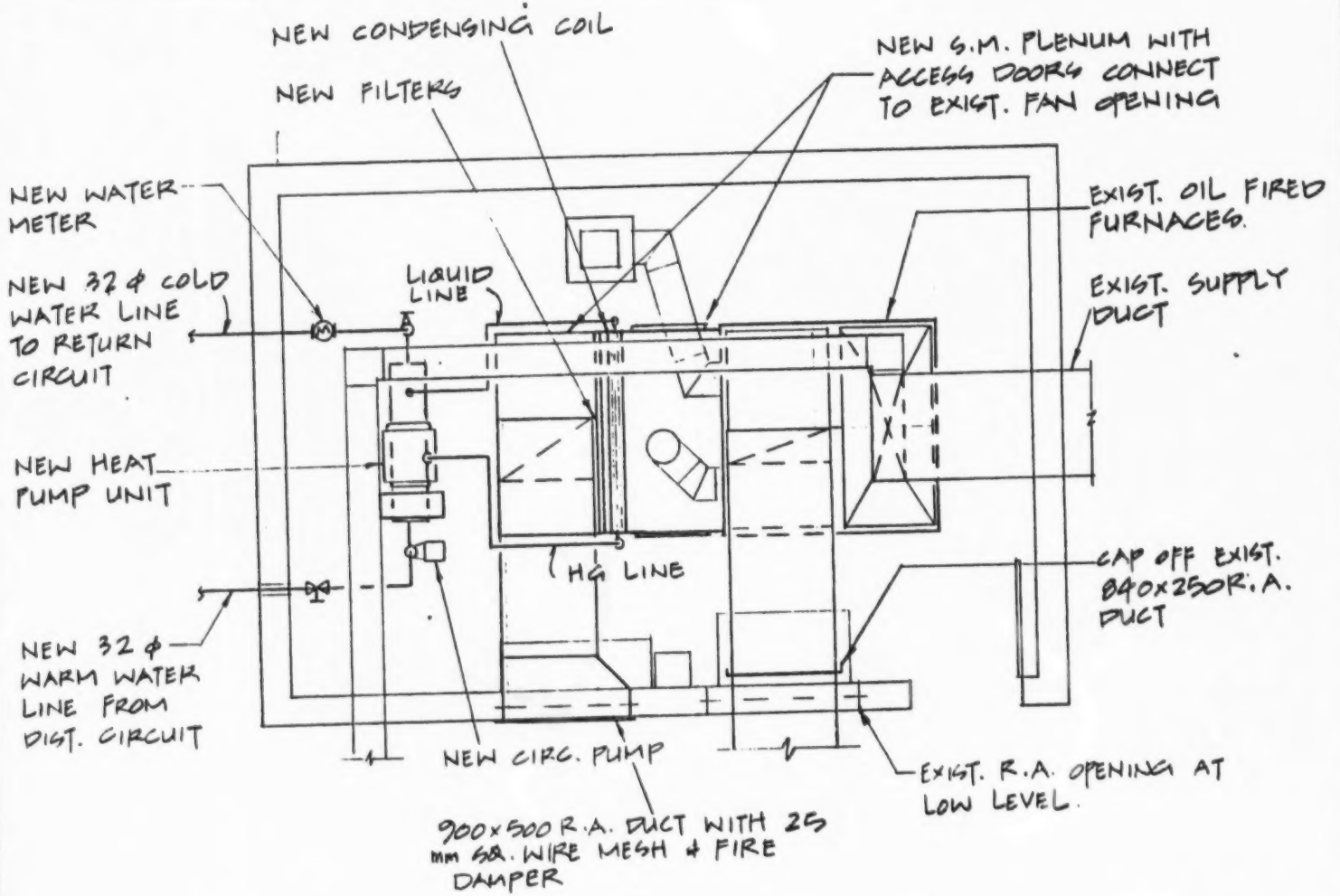
SCALE
DATE
DES DWN
CKD APP
PROJ. NO. 27215

DWG. NO.
TABLE 6.2


NEW CONDENSING COIL
NEW FILTERS
NEW S.M. PLENUM WITH ACCESS DOORS CONNECT TO EXIST. FAN OPENING
NEW WATER METER
EXIST. OIL FIRED FURNACES.
NEW 32 ϕ COLD WATER LINE TO RETURN CIRCUIT
LIQUID LINE
EXIST. SUPPLY DUCT
NEW HEAT PUMP UNIT
HG LINE
CAP OFF EXIST. 840x250 R.A. DUCT
NEW 32 ϕ WARM WATER LINE FROM DIST. CIRCUIT
NEW CIRC. PUMP
EXIST. R.A. OPENING AT LOW LEVEL.
900x500 R.A. DUCT WITH 25 mm SQ. WIRE MESH & FIRE DAMPER

FURNACE ROOM PLAN
HEAT PUMP INSTALLATION

DATE	REVISIONS	APP

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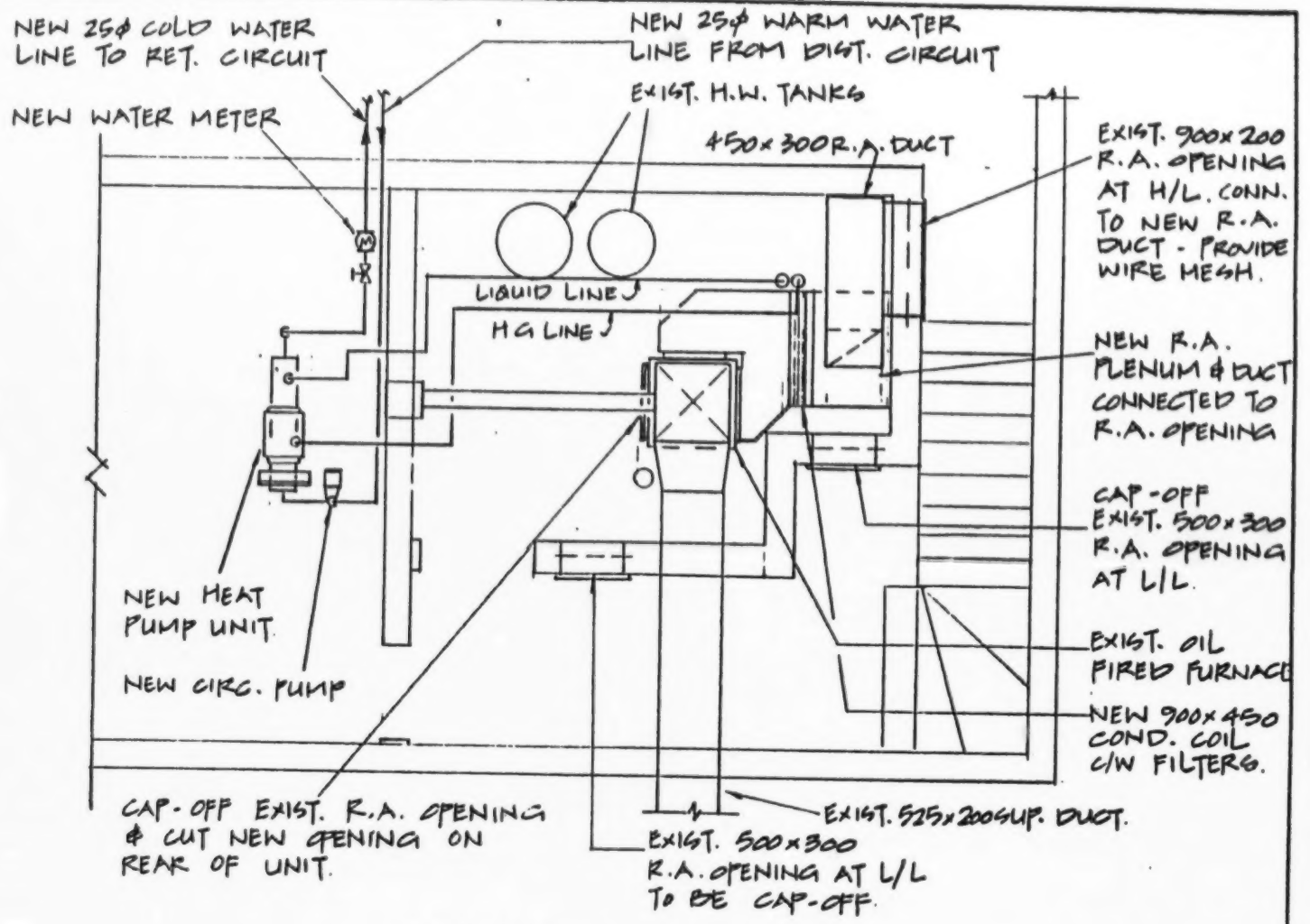
Reid Crowther

COMMUNITY HALL
MAYO
YUKON

SCALE 1:50
DATE SEPT. 12/84
DES WG DWN
CKD APP
PROJ. NO. 29015

DWG. NO.
M - 1


NEW 25ϕ COLD WATER LINE TO RET. CIRCUIT
NEW 25ϕ WARM WATER LINE FROM DIST. CIRCUIT
NEW WATER METER
EXIST. H.W. TANKS
450 x 300 R.A. DUCT
EXIST. 900 x 200 R.A. OPENING AT H/L. CONN. TO NEW R.A. DUCT - PROVIDE WIRE MESH.
LIQUID LINE
H.G. LINE
NEW R.A. PLENUM & DUCT CONNECTED TO R.A. OPENING
CAP-OFF EXIST. 500 x 300 R.A. OPENING AT L/L.
NEW HEAT PUMP UNIT
NEW CIRC. PUMP
EXIST. OIL FIRED FURNACE
NEW 900 x 450 COND. COIL C/W FILTERS.
CAP-OFF EXIST. R.A. OPENING & CUT NEW OPENING ON REAR OF UNIT.
EXIST. 525 x 200 SUP. DUCT.
EXIST. 500 x 300 R.A. OPENING AT L/L TO BE CAP-OFF.

FURNACE ROOM PLAN

HEAT PUMP INSTALLATION

DATE | REVISIONS | APP

CURLING CLUB

MAYO, YUKON

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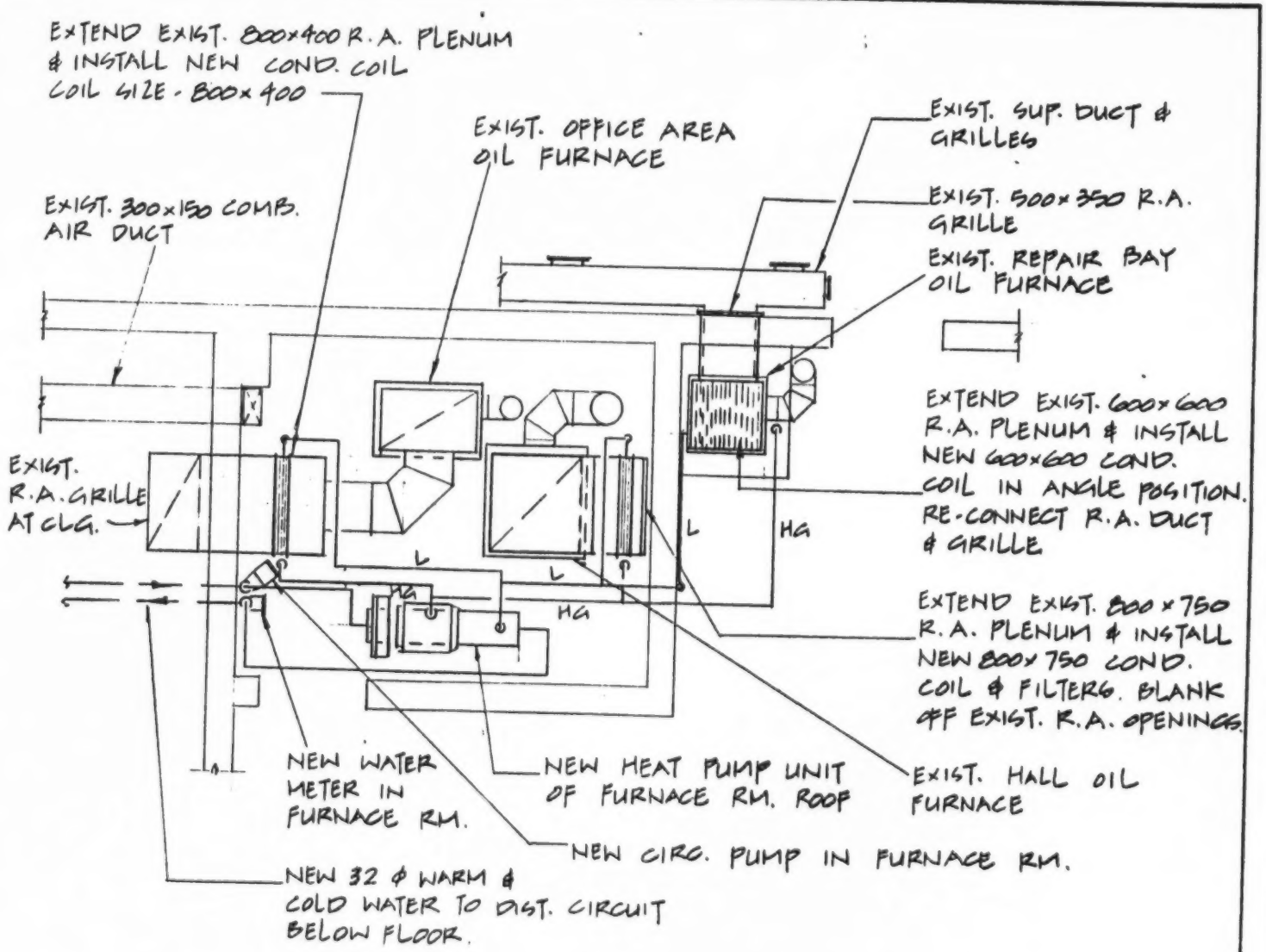
SCALE 1:50
DATE SEPT. 12/84
DES WC DWN
CKD APP
PROJ. NO. 29015
DWG. NO. M-2


EXTEND EXIST. 800x400 R.A. PLENUM & INSTALL NEW COND. COIL COIL SIZE - 800x400
EXIST. OFFICE AREA OIL FURNACE
EXIST. SUP. DUCT & GRILLES
EXIST. 500x350 R.A. GRILLE
EXIST. REPAIR BAY OIL FURNACE
EXIST. 300x150 COMB. AIR DUCT
EXIST. R.A. GRILLE AT CLG.
EXTEND EXIST. 600x600 R.A. PLENUM & INSTALL NEW 600x600 COND. COIL IN ANGLE POSITION. RE-CONNECT R.A. DUCT & GRILLE
EXTEND EXIST. 800x750 R.A. PLENUM & INSTALL NEW 800x750 COND. COIL & FILTERS. BLANK OFF EXIST. R.A. OPENINGS.
NEW WATER METER IN FURNACE RM.
NEW HEAT PUMP UNIT OF FURNACE RM. ROOF
EXIST. HALL OIL FURNACE
NEW CIRC. PUMP IN FURNACE RM.
NEW 32 ϕ WARM & COLD WATER TO DIST. CIRCUIT BELOW FLOOR.
L
HG

FURNACE ROOM PLAN

HEAT PUMP INSTALLATION

DATE	REVISIONS	APP

FIRE HALL
MAYO, YUKON

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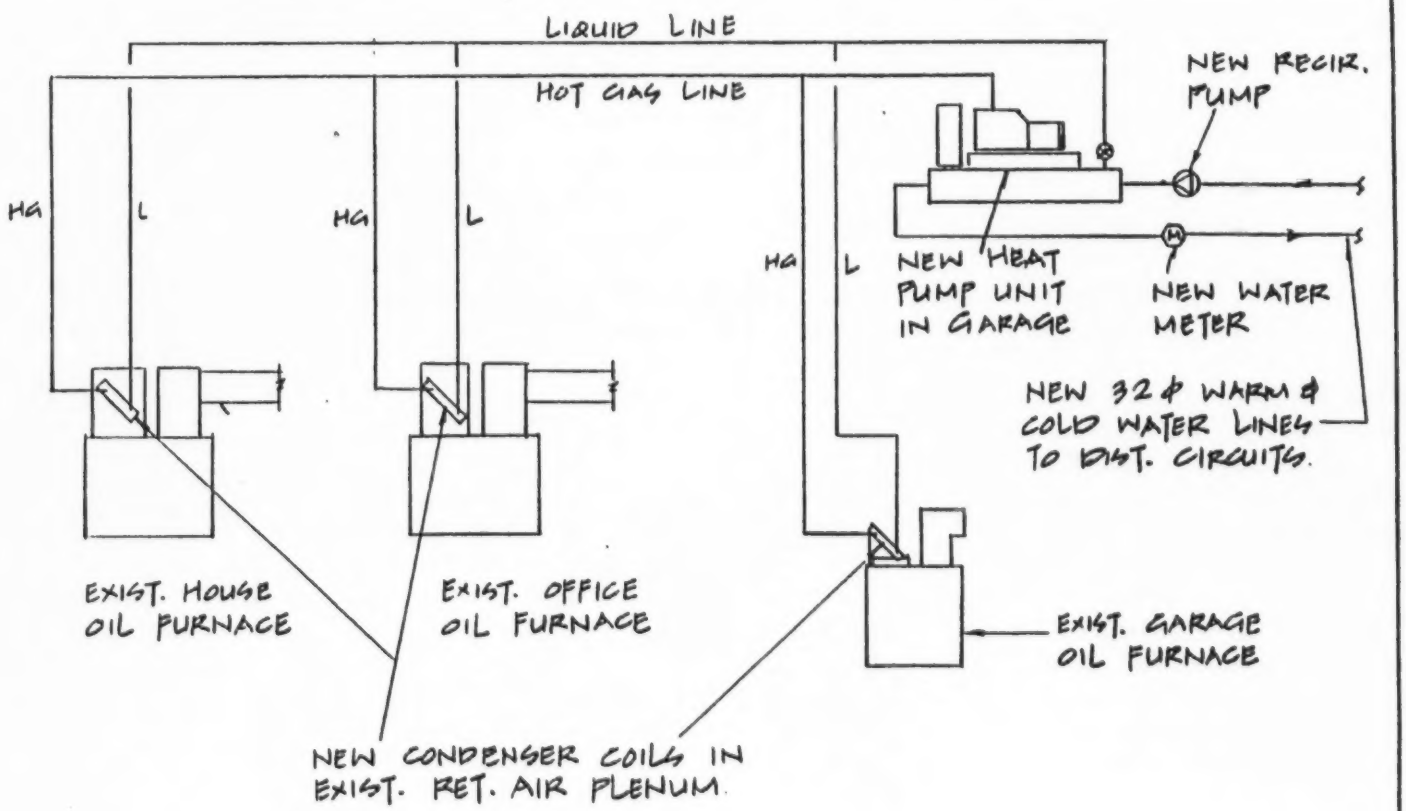
SCALE 1:50
DATE SEPT. 12/84
DES WC DWN
CKD APP
PROJ. NO. 29015
DWG. NO. M-3



SYSTEM SCHEMATIC

HEAT PUMP INSTALLATION

DATE	REVISIONS	APP

R.C.M.P. STATION
MAYO, YUKON

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SCALE N.T.S.
DATE SEPT. 12/84
DES WC DWN
CKD APP
PROJ. NO. 29015

DWG. NO.
M - 4

SYSTEM SCHEMATIC

HEAT PUMP INSTALLATION

DATE	REVISIONS	APP

R.C.M.P. HOLDING HOUSE
MAYO, YUKON

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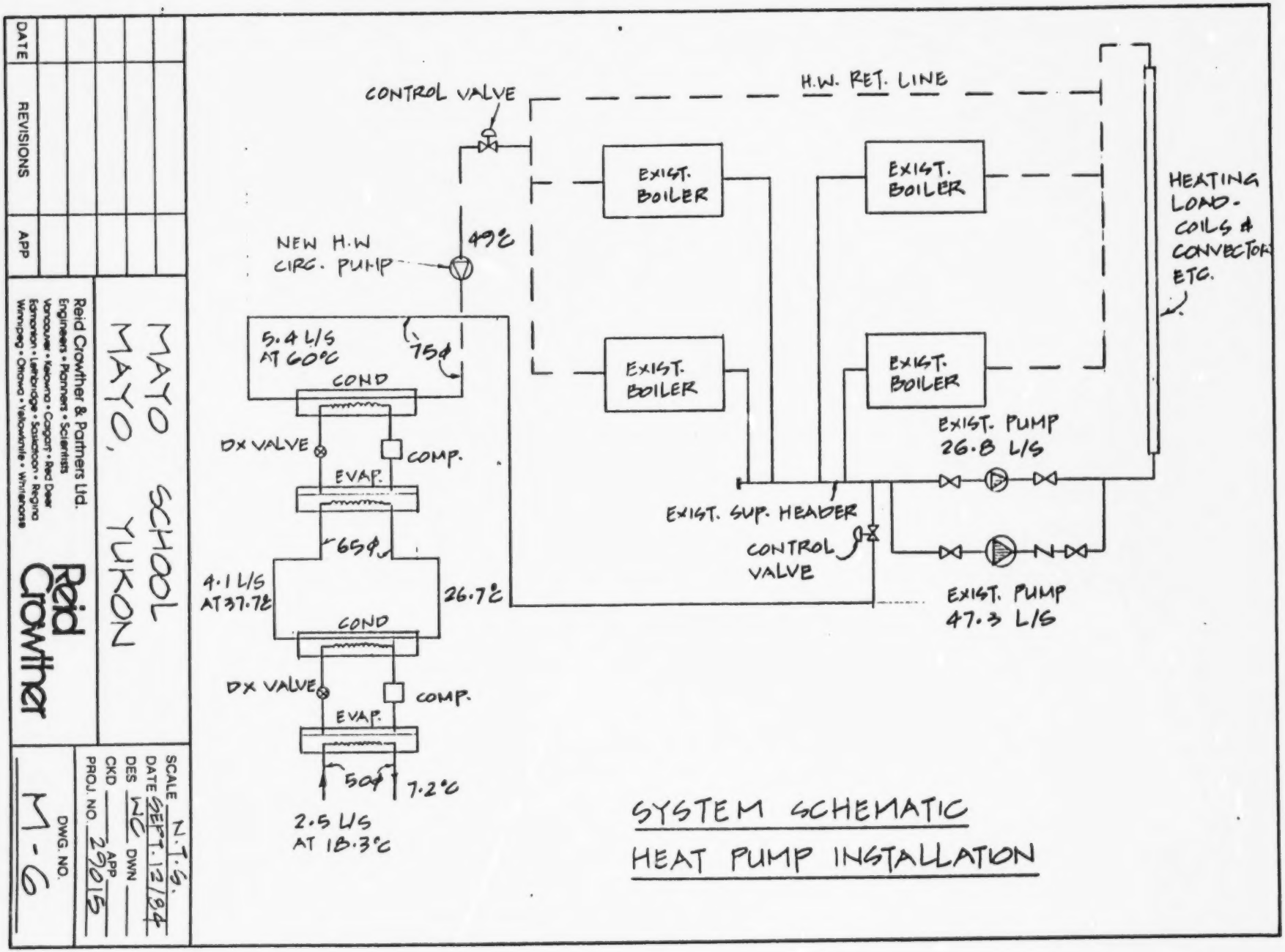
SCALE N.T.S
DATE SEPT. 12/97
DES WC DWN
CKD APP
PROJ. NO.

DWG. NO
M - 5


CONTROL VALVE
H.W. RET. LINE
EXIST. BOILER
EXIST. BOILER
EXIST. BOILER
EXIST. BOILER
HEATING LOAD - COILS & CONVECTOR ETC.
NEW H.W CIRC. PUMP
49°C
5.4 L/S AT 60°C
75¢
COND
DX VALVE
COMP.
EVAP.
65¢
4.1 L/S AT 37.7¢
26.7°C
COND
DX VALVE
COMP.
EVAP.
50¢
7.2°C
2.5 L/S AT 18.3°C
EXIST. PUMP 26.8 L/S
EXIST. SUP. HEADER
CONTROL VALVE
EXIST. PUMP 47.3 L/S
SYSTEM SCHEMATIC
HEAT PUMP INSTALLATION
DATE
REVISIONS
APP
MAYO SCHOOL
MAYO, YUKON
Reid Crowther & Partners Ltd.
Engineers • Planners • Scientists
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Edmonton • Lethbridge • Saskatoon • Regina
Winnipeg • Ottawa • Yellowknife • Whitehorse
Reid Crowther
SCALE N.T.S.
DATE SEPT. 12/94
DES WC DWN
CKD APP
PROJ. NO. 29015
DWG. NO. M-6